WE CLAIM:

1. A method for electrolyzing water to produce oxygen, hydrogen and heat, which comprises the steps of:

(i) providing an electrochemical cell comprising an isotopic hydrogen storage cathode, an electrically conductive anode and an ionically conducting electrolyte comprising water, and

(ii)impressing a repeating sequence of voltages across said cathode and anode comprised of at least two cell voltage regimes, a first cell voltage regime consisting of a voltage sufficient to enhance cathodic absorption of hydrogen, and a second cell voltage regime consisting of at least one voltage pulse which is at least 2 times the voltage of the first cell voltage regime for a total duration no greater than 0.10 seconds.

2. The method of Claim 1, wherein the voltage of said first cell voltage regime ranges from about 1 to about 10 volts, and the voltage pulse of said second cell voltage regime ranges from 2 times to 1,000 times the voltage of said first cell voltage regime, the total duration of said voltage pulse ranging from about 0.5 nanoseconds to 0.10 seconds.

3. The method of Claim 1 wherein the second cell voltage regime is dovetailed onto said first cell voltage regime.

4.The method of Claim 1 wherein the second cell voltage regime is superimposed onto the first cell voltage regime.

5. The method of Claim 2 wherein the second cell voltage regime is dovetailed onto said first cell voltage regime.

6. The method of Claim 1 wherein the electrolyte comprises a solvent selected from the group consisting of water, deuterium oxide, tritium oxide and mixtures thereof.

7. The method of Claim 6 wherein the electrolyte includes an ionic compound.

8. The method of Claim 7 wherein the ionic compound is a metal oxydeuteride, metal oxytriteride, metal hydroxide or mixtures thereof.

9. The method of Claim 2 wherein the electrolyte comprises a solvent selected from the group consisting of water, deuterium oxide, tritium oxide and mixtures thereof.

10. The method of Claim 9 wherein the electrolyte includes an ionic compound.

11. The method of Claim 10 wherein the ionic compound is a metal oxydeuteride, metal oxytriteride, metal hydroxide or mixtures thereof.

12. The method of Claim 1 wherein the anode comprises a noble metal oxide.

13. The method of Claim 1 wherein the anode is a gas diffusion anode.

14. The method of Claim 1 wherein the hydrogen absorbed by the cathode is a member selected from the group consisting of $H_2, D_2, T_2; HD, HT; H^-, D^-, T^-$ and their metal hydrides; H•, D• and T•.

15. The method of Claim 2 wherein the hydrogen absorbed by the cathode is a member selected from the group consisting of $H_2, D_2, T_2; HD, HT; H^-, D^-, T^-$ and their metal hydrides; H•, D• and T•.

16. The method of Claim 1 wherein the cathode comprises an electrically conductive material selected from the group consisting of palladium, palladium alloys, doped palladium, titanium, titanium alloys, indium, indium alloys, nickel, nickel alloys and carbonaceous materials capable of absorbing hydrogen.

17. The method of Claim 1 wherein the repeating sequence of voltages includes a step of applying a positive potential sufficient for cleaning the cathode.

18. The method of Claim 2 wherein the repeating sequence of voltages includes a step of applying a positive potential sufficient for cleaning the cathode.

19. The method of Claim 1 wherein the repeating sequence of voltages includes a step of reequilibrating the cathode in the region of zero potential.

20. The method of Claim 2 wherein the repeating sequence of voltages includes a step of reequilibrating the cathode in the region of zero potential.

21. The method of Claim 17 wherein the repeating sequence of voltages includes the step of applying a negative potential for further cathodic absorption of hydrogen.

22. The method of Claim 18 wherein the repeating sequence of voltages includes the step of applying a negative potential for further cathodic absorption of hydrogen.

23. The method of Claim 1 wherein the electrochemical cell includes a divider for separating the cell interior into anode and cathode compartments.

24. The method of Claim 23 wherein the divider is an ion exchange membrane.

25. The method of Claim 1 wherein the electrochemical cell is a solid polymer electrolyte type.

26. The method of Claim 2 wherein the isotopic hydrogen storage cathode comprises palladium.

27. The method of Claim 1 wherein the electrochemical cell is operated under supercritical or near supercritical conditions.

28. An apparatus for electrolyzing water for the production of hydrogen, oxygen and heat, which comprises:

(i) an electrochemical cell having an isotopic hydrogen storage cathode, an electrically conductive anode and a compartment for holding an ionically conducting electrolyte comprising water, and

(ii) means for applying to said cathode and said anode at least two alternating voltage regimes, a first cell voltage regime consisting of a voltage ranging from about 1 to about 10 volts, and a second cell voltage regime consisting of at least one voltage pulse ranging from 2 times to 1,000 times the

voltage of said first cell voltage regime, the total duration of said voltage pulse ranging from about 0.5 nanoseconds to 0.10 seconds.

29. The apparatus of Claim 28 wherein said means for applying an alternating voltage regime comprises means for providing a train of timing pulses, means for counting and decoding said timing pulses, and means for generating sequences of pulsed potentials at predetermined times in response to said counted and decoded pulses.

30. The apparatus of Claim 29 wherein said means for providing alternating pulsed potentials comprises a circuit which generates a periodic potential comprising a constant current or positive potential for a predetermined time interval, followed by a constant current or negative potential for a predetermined time interval, followed by a brief high voltage pulse for a predetermined time interval.

31. A pulsed drive system for an electrochemical cell, which comprises means for providing a train of timing pulses, means for counting and decoding said timing pulses, and means for generating alternating pulsed potential sequences across an anode and a cathode of said cell at predetermined times in response to said counted and decoded pulses.

32. The pulsed drive system of Claim 31 wherein said means for providing a train of timing pulses comprises a clock oscillator, said means for counting and decoding said timing pulses comprises a binary counter in combination with a decoder, and the means for generating alternating pulsed potential sequences comprises a circuit which generates a periodic potential comprising a constant current or positive potential for a predetermined time interval, followed by a constant current or negative potential for a predetermined time interval, followed by a brief high voltage pulse for a predetermined time interval.